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ABSTRACT

Continuous Integration Techniques (CIT) encourage interdisciplinary study by focusing on strategies to synergistically combine information from two or more subject areas. These techniques may be more meaningful for students than schooling's normal unidimensional learning techniques because real life occurs within multiple contexts. Such techniques seem to be suitable for nearly all grade levels and subjects. Some activities that facilitate interdisciplinary study are: (1) writing across the curriculum; (2) incidental grammar instruction; (3) constant spelling evaluation; (4) storytelling and interpretation; (5) facilitation of the inquiry process; (6) discussion of math concepts whenever they arise; (7) study of music as a way to enhance emotional, aesthetic, and kinesthetic awareness; and (8) use of instructional media. To be effective, CIT must meaningfully add to students' knowledge or reinforce lessons already learned. (Includes 43 references and 3 charts.) (JW)

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Techniques for promoting interdisciplinary education in the classroom

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Introduction

This article describes *Continuous Integration Techniques* (CIT), strategies for combining information from two (or more) subject areas to enhance the understanding of each. Although the methods are not new, their classification as CIT denotes their usefulness as part of an on-going, systematic instructional strategy for fostering interdisciplinary lessons in almost any educational environment. By linking different subject areas teachers can compensate for some of the shortcomings of the familiar, but compartmentalized, academic disciplines.

The Problem

With the aggregate of human knowledge doubling approximately every five years it is not difficult to see why schools are under constant pressure to add more information to an already robust curriculum. Indeed, well-developed and sophisticated curriculum guides reflect the difficult job that teachers have in consistently presenting meaningful and comprehensive lessons to their students. Additionally, the educational process is affected by factors such as overcrowded classrooms, an unequal distribution of resources among schools, teacher stress and the students' home environment.

Many educators believe that a major impediment to more effective school programs is the deliberate, rigid and artificial separation of the curriculum into discrete and unconnected academic subject areas (Smith & Westhoff, 1992; Berliner, 1992; Smith, 1986; Devine, 1982; Carlgren, 1977; Gordon & Poze, 1972). These subject-matter divisions tend to foster a two-dimensional

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textbook approach to learning that neatly categorizes information into right and wrong answers and focuses on a single subject at a time, such as math, science, social studies or English, as though each one existed independently of the others. In the short term, this two-dimensional approach relies heavily upon workbooks and rote learning, leading to a normal distribution of test scores and yearly grade level advancement for most students. In the long run, however, the results are often unsatisfactory for both students and society (Carnegie Forum on Education and the Economy, 1986).

Why Integration?

While schools offer regularly scheduled periods of easily identifiable, standardized subject area lessons, activities outside school take place within multi-layered, episodic, culturally-bound, integrated contexts. For example, a simple transaction such as paying the electric bill combines science (to understand electric power), English (to read and understand the bill), history (to understand why the rates have gone up or down), culture (to know the many ways that the bill can be paid), and mathematics (to understand how the bill was calculated). The transaction can be affected by time (Has my paycheck been deposited yet?), or context (We were gone all month so why is the bill so high?). Although teaching individual subjects has its uses, one hallmark of an educated person is the ability to synthesize learning experiences, making his or her education more than just the sum of separate academic parts. It follows that instruction is most effective when it helps students to develop and appreciate the overlap among areas such as math, English, science, physical education, social studies, art, music and moral education. By encouraging students to integrate apparently unconnected concepts teachers are helping them to develop a solid foundation for operating in a three-dimensional, interconnected and complex world.

Integrating the Curriculum

There are many examples of successful interdisciplinary lessons, including the following: Storytelling, music and art (Bonnert,

1980); social studies and morality (Chen & Onn, 1985); English and music (Cheng, 1984); writing and math (Chong & McCracken, 1990; Kaur, 1992); computers and art (Duthie, 1990); history and puppetry (Diploma Class of 1986, 1987); poetry and science (Poon, 1990); math and moral education (Tan, 1982); math and chemistry (Thye, 1987); storey-telling and social studies (Tey & Loh, 1986); poetry and geography (Yee, 1988); literature across the curriculum (Yeo, 1985); and food with math, science and language arts (Tng, 1987).

While the above examples illustrate the combination of different academic subjects within a planned context, Continuous Integration Techniques *are suitable for use in almost any lesson and at nearly every grade level.* Although some integration takes place in most classrooms, either intentionally or incidentally, the systematic use of CIT can help to habitualize the process so that it occurs more often.

Assumptions

The basic assumptions that are necessary for using CIT are as follows:

1. Teachers know the course objectives or they can find them in the appropriate curriculum guides.

2. They can identify the necessary prerequisites for learning each procedure or concept.

3. Teachers are familiar with their students' cultural and social backgrounds.

4. They *want* to teach interdisciplinary lessons.

An Overview of Continuous Integration Techniques

With patience, planning and practice curriculum integration can become part of a teacher's normal presentation format. The following is a brief summary of some integration strategies.

Writing

Instructional strategies based upon the premise of *writing across the curriculum* are a fundamental component of many interdisciplinary programs (Elbow, 1981; Moffet, 1981; Frank, 1979; Pirsig, 1975). Most writing activities are suitable for curriculum integration because they encourage students to explore topics at a deeper level then they usually do in a passive lecture format, making the links between concepts more apparent and thereby more meaningful. Writing activities are used worldwide in almost every academic area to enhance subject-matter content, students' matacognitive strategies and teachers' own rhetorical skills.

Grammar and Punctuation

Educators should be consistent with grammar and punctuation because their language serves as a powerful model for students, particularly in the primary grades. Teaching and reinforcing grammatical constructions are frequently accomplished more effectively through *incidental instruction* than with the unimaginative exercises which routinely characterize English language lessons. The continuous integration of grammar and punctuation with other topics provides better reinforcement than students usually get in a single, concentrated class period. This heightened awareness towards language should also include the use of gender-neutral terminology to avoid the unintentional sexual bias that often characterizes many commercially developed educational materials (Gupta & Lee, 1990; Venolia, 1991; Spender, 1980; King, 1990; Gilligan, 1982).

Spelling

Spelling should always be checked for correctness and teachers ought to present new or troublesome words in creative ways that also give students repeated practice in different contexts. In addition, it is often helpful to **hilight** or underline the difficult parts of a word because people usually remember how it begins and ends, but they frequently have difficulty with the middle section. When students perceive differences they are more likely to remember them.

Stories

Stories and parables are part of a powerful instructional genre and are suitable for almost any classroom context. Using a story to introduce information, to illustrate points or to provide moral lessons, is often an underutilized technique, especially in secondary education. Effective storytelling skills are not difficult to cultivate since most people can tell good stories when they have a personal interest in them. The teacher's task is to cultivate an interest in all the subjects they teach and to communicate that interest to their students.

Questioning

Questioning is a good instructional strategy used in all subject areas. Dillon (1988) and Kissock and Lyortsuun (1982), among others, provide illustrative guides for classroom questioning. Educators can also use the inquiry process to help students to appreciate the connections between different academic areas. For example, a social studies unit such as the *Neighborhood* can include queries about remuneration (economics), weights and measures (mathematics), directions (geography), recycling (ecology), production processes (science), pollution (morality), and even recipes (cooking). These questions, and their answers, will convincingly illustrate that the neighborhood is part of a network of integrated subjects and ideas.

Contrary to what often happens, teachers should use a student's incorrect or incomplete answer to enhance learning rather than cut-off communication. For example, consider the following:

Teacher: So what is it that causes day and night?
Student: I'm not sure. Is it because the earth goes around the sun?
Teacher: No, who knows the right answer?

It is likely that other students will have similar misconceptions. Instead of continuing the search for the "correct" answer, the teacher can use the "incorrect" response to help to reteach the information, and at the same time acknowledge the student's honest attempt at an intuitive explanation.

Teacher: So what is it that causes day and night?
Student: I'm not sure, is it because the earth goes around the sun?
Teacher: Okay, so you know that it has something to do with the relationship between the earth and the sun. Now let's look at the model again and please describe what is happening.
Student: The earth is turning around while the sun doesn't. It's the earth's turning around that causes day and night.
Teacher: Good, yes, it is the earth's *rotation* that causes day and night. Now let's see what happens when the earth *revolves* around the sun.

An incorrect answer is often more valuable than a correct one because it generally indicates that one or more students don't understand a particular concept or procedure. The teacher then has the opportunity to present the information again, in a different way, by building upon a part of the student's initial response.

Questions such as "Do you understand?" or, "Is that clear?" are unsuitable for determining whether something has been learned. These *useless questions* require only a reflexive "yes" or "no" response and can lead to difficulties when assessing students' progress in learning the curriculum (Sponder, 1993).

Math

Math skills and concepts, from measurement to algorithms, are a fundamental part of almost every other academic subject. Teachers should examine their lessons to ensure that mathematical ideas are used clearly and correctly. For example, a procedure such as *estimation* is an important mathematical strategy that is used to check for approximate correctness. We utilize estimation in everyday transactions, such as follows:

- Shopping: *This dress is being sold at the Stock Mart so it should cost only about $20. I won't pay more.*

- Time and Distance: *It's raining so I will need over an hour to get to work today. I'd better leave early.*

- Paying Bills: *We made many phone calls this month so I should raise my GIRO limit.*

Teachers can ask questions that require estimation and they should remind students that estimating an answer is a mathematical procedure that is appropriate for many situations.

Music

Music has an important role in any area although formal schooling tends to emphasize answer reproduction while regularly ignoring emotions, aesthetics and kinesthetic activities. The use of music can help educators to tap into several enjoyable and powerful learning strategies. Some of the methods that use music include *Raps and Rhymes in Maths* (Baker & Baker, 1991) and *Tune Into English* (CDIS & EDP, 1992).

Art

Art is suitable for almost any subject, although artistic methods are often regarded by many as unscientific, hard to measure or too specialized for the average teacher (who feels that he or she cannot draw a straight line). There are a number of educators, however, who regard the teaching profession itself as an art (Joyce & Weil, 1986; Gardner, 1975; Winkler, 1975), and much of the history of education involves the transmission and preservation of humanity's artistic heritage. As Picasso put it, "Every child is an artist. The problem is how to retain an artist once (they) grow up." Using art for curriculum integration includes activities such as painting, drawing, designing and computer graphics. Additional methods involve employ light, color, form, texture, and patterns.

Media

Instructional media is an important component of any lesson that can easily be used to facilitate curriculum integration. Since instructional materials are created in advance of a lesson they can be designed to introduce and reinforce interdisciplinary concepts.

Media can also support other Continuous Integration Techniques (see Figure 1).

Figure 1. Examples of Continuous Integration Techniques

CIT	Possible Uses	(Some) Sources
Writing	Many writing activities including poetry, drama and using literature are suitable.	Elbow, 1981; Frank 1979; Moffet, 1981; Yeo, 1985, Koch, 1970
Grammar	Reinforce good grammatical usage through media, worksheets, OHTs and oral presentations. Using games can also be fruitful.	Strunk & White, 1979; Venilia, 1991; Wagner, Hosier & Blackman, 1971
Spelling	Use difficult words in lessons and in media. Hilight the troublesome parts of a word.	Devine, 1982; Wagner, Hosier & Blackman, 1971
Stories	Look for stories behind subject matter concepts and use them for analogies and relevant examples.	Smith, 1990; Gardner, 1975; Gagne, 1985
Questioning	Use questions well. Avoid looking for the *correct* answers and *redirect* incorrect ones.	Dillon, 1988; Kissock & Lyortsuun, 1982; Loh & Chan, 1987; Sponder, 1993
Math	Use general math strategies such as estimation, prediction and pattern-identification. Identify and use appropriate grade-level math concepts.	Castellano & Feinstein, 1970; Grimm & Mitchell, 1977; Gagne, 1985
Music	Music methods are suitable for many subjects. Rhythmic activities are especially good in the primary grades.	Baker & Baker, 1991; CDIS & EDP, 1992
Art	Search for the artistic components of any subject. Draw, paint, color and use artistic examples.	Duthie, 1990; Bonnert, 1980
Media	Combine the above techniques with instructional media. Design media with integration in mind.	Heinich, Molinda & Russell, 1993; Kemp & Smellie, 1989

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Planning For Continuous Integration

As teachers plan their lessons they can use a checklist such as the one in Figure 2 to assist them in creating integrated activities.

Figure 2. A CIT checklist

Subject:	**Objective(s):**
Integration Technique	**Possible uses**
Writing	
Grammar	
Spelling	
Stories	
Questioning	
Math	
Music	
Art	
Media	

The teacher writes the lesson's subject and objectives at the top of the checklist. For example, *Social Studies, Pioneers of Singapore.* He or she then goes through the list of integration techniques to generate ideas (see Figure 3).

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Figure 3. A completed CIT checklist

Subject: Social Studies	**Objective(s):** Students will learn about the pioneers of Singapore.
Integration Technique	**Possible uses**
Writing	Read or write poetry about them. Do a play? Explore the term *pioneer*.
Grammar	Use the construction *going to* in written and oral directions.
Spelling	Hilight *estuary, piece and antidissestablishmentarianism.*
Stories	Check books for good anecdotes about Raffles: Look for humorous bits.
Questioning	Question students to see what they know and use that information to start the lesson.
Math	How many years ago did Raffles arrive? Estimate distances from here to different places.
Music	Play old sailing songs and folktunes or see if the class knows them.
Art	Paintings of old Singapore. Perhaps use a drawing activity or 3-D model? Use multimedia.
Media	Directions on media. Use the CDIS videodisc. Use an OHT and a handout.

The teacher now has a few general ideas for the upcoming class(es). At first, the checklist serves as a scaffolding exercise to help in developing a specific presentation, but eventually teachers

will evolve their own methods and procedures for curriculum integration. Hopefully, these strategies will become a permanent feature of their teaching persona.

How Much Integration?

It is important not to overburden a class with extraneous or trivial information, but rather to continually create and use opportunities for interdisciplinary learning. Although some people may fear that there is not enough time to combine subjects it is more likely that the separation of the curriculum into unconnected parts *reduces* the time that teachers can devote to each topic. Continuous integration does not add anything new to the total knowledge base but *better reinforces what students may have already learned.* By combining subjects students have more time to consolidate and strengthen their expanding knowledge base, giving them additional opportunities to understand ideas in meaningful contexts.

Conclusion

Committed to teaching a full curriculum but with limited time to deliver it, educators can enhance their lessons by using creative methods to reinforce and to integrate concepts while promoting students' understanding. While not offered as an instructional panacea, Continuous Integration Techniques can be a profitable strategy for presenting information in a holistic, contextually-based format that is relevant to the world outside of the classroom.

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